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Göran Skogh

Charles Stuart

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A THEORY OF PROPERTY RIGHTS AND CRIME

by

Göran Skogh

and

Charles Stuart[†]

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A THEORY OF PROPERTY RIGHTS AND CRIME

Much of the theory of exchange rests on an implicit assumption that property rights exist and are costlessly enforced. An exception is the recent work of Demsetz (1964, 1967). Following Coase's (1960) essay on social cost, Demsetz has pointed out that in a world of positive enforcement and other transaction costs, the existence of enforced, private property rights allows decisions on the allocation of resources to be made bilaterally instead of multilaterally. Since bilateral agreements are likely to be less costly to transact than multilateral ones, he then argues that a system of exchangeable property rights provides an attractive basis for economizing on the costs of allocating resources in society.

In the present paper, we will examine a different motive for the emergence of property rights--that, even in the absence of trade, a system of enforced property rights can reduce the resources devoted by individuals to conflicts over distribution. Such a motive is more fundamental than that advanced by Demsetz as it goes to the heart of the problems of the observance and enforcement of property rights; for these to have meaning, the possibility of distributional conflicts must be admitted.

The framework for the analysis is contractarian. In the spirit of the writings of Hobbes, Locke and Rousseau, we begin with a primordial "state of nature" where property rights, and hence property crimes, do not exist.¹ Individuals may devote their time to three activities: 1) producing units of a consumption good; 2) attempting to transfer units of the good from others; and 3) attempting to protect their own stocks of the good. The

natural state thus has a law-of-the-jungle character:

"To this warre of every man against man...nothing can be Unjust... .Where there is no common Power, there is no Law: where no Law, no Injustice... .It is consequent also to the same condition, that there be no Propriety, no Dominion, no Mine and Thine distinct; but onely that to be every mans that he can get; and for so long, as he can keep it. And thus much for the ill condition, which man by meer Nature is actually placed in"

(Leviathan, p. 63)

We will show that the individuals in this "state of warre" may gain from the ratification of a social contract which establishes property rights and mandates punishment for violators of the rights of others. Such a mechanism of social order has been described by Hobbes:

..."there must be some coercive Power, to compell men... by the terrour of some punishment, greater than the benefit they expect by the breach of their Covenant; and to make good that Propriety, which by mutuall Contract men acquire, in recompence of the Universall Right they abandon: and such power there is none before the erection of a Commonwealth."

(Leviathan, pp. 71-72.)

The gains from the establishment of the social contract consist of a reduction in the resources devoted toward non-socially-productive activities-- that is, toward attempted transfer from others and self-protection--less the costs of enforcement. Perhaps the clearest classical statement of these gains is Rousseau's:

"What a man losses as a result of the Social Contract is his natural liberty and his unqualified right to lay hands on all that tempts him, provided only that he can encompass its possession. What he gains is civil liberty and the ownership of what belongs to him."

(The Social Contract, Chapter VIII.)

In our analysis, all individuals are assumed to be identical. All can thus expect to benefit equally ex ante from the formation of the social control mechanism and hence we predict that all will agree to it, even though some might be harshly punished ex post. In this sense, the analysis provides a positive basis for the emergence of property rights and punishment for property crimes.

By specifying the net resource savings from different levels of enforcement of property rights, it will be possible to determine the amount of enforcement which the agents in the model find optimal and the corresponding optimal amount of property crime. This last topic has been treated by Becker (1968). In his analysis, crime is assumed to impose damage on society but is costly to prevent.² The socially optimal amount of crime is then that level which makes the sum of enforcement costs and damage due to crime a minimum. However, Becker's damage function is never clearly specified. As its only argument is the amount of crime committed, it can be interpreted as embodying the value judgement that crime is a bad for society. One outcome of the present analysis will thus be to provide a deeper foundation for a Becker-like damage function for property crimes. In particular, crime need not be a bad in its own right but is undesirable because it uses up resources.

I. A WORLD WITHOUT PROPERTY RIGHTS

We first consider the allocation of resources in a world where "that to be every mans that he can get; and for so long, as he can keep it." In this world, control over a good is a prerequisite for its consumption; property rights are not. To simplify the exposition, we will speak of this world as an isolated portion of a tropical jungle which contains a tribe of n identical individuals. The assumption that individuals are identical reflects the notion that there need be no principal difference between thieves and victims. It also purges distributional considerations from the model (see section III). Each individual is endowed with X units of a consumption good--say bananas--and with E units of time per period³ and each attempts privately to maximize the number of bananas which he consumes at the end of the period.⁴ This is done by using time as a factor in the production of bananas transferred from others, self-protection against attempted transfers by others, and additional picking of bananas.

A unit of time is assumed to give a fixed number of picked bananas which we normalize to one by an appropriate choice of units. If individual i devotes p^i units of time to self-protection and t^{ij} units of time to attempted transfer from another individual j , he will thus end up picking x^i bananas where the time constraint

$$E = p^i + \sum_{j \neq i} t^{ij} + x^i \quad (T)$$

must hold.

The outcome of bilateral conflicts over the control of bananas is given by a twice differentiable expected transfer function $\ell(\cdot)$ where $\ell(p^i, t^{ji})$ bananas are (expected to be) transferred from (lost by) individual i to individual j if i devotes p^i units of time to self-protection and j devotes t^{ji} units of time to attempted transfer from i .⁵ An individual cannot transfer bananas to himself without expending some time; i.e., $\ell(p^i, 0) = 0$. Otherwise, increases in time devoted to attempted transfer lead to increased transfers, but at a decreasing rate: $\ell_t > 0$ and $\ell_{tt} < 0$. (Subscripts denote partial derivatives; superscripts for individuals are suppressed.) Similarly, increases in i 's self-protection decrease losses via transfer but at a decreasing rate: $\ell_p < 0$ and $\ell_{pp} > 0$ (as long as some other agent j opposes i 's holdings by setting $t^{ji} > 0$). These increases in self-protection work by decreasing the marginal productivity of time devoted by others to attempted transfer: $\ell_{pt} < 0$. Activities such as placing locks on doors (or even using doors or walls) or staying home to guard one's bananas fit this formulation of protection.⁶ Finally, to assure that an individual never loses more bananas than he has, we assume that $X - (n-1)\ell(0, E) \geq 0$. This states that even if all individuals but one devoted all of their time to attempted transfer from the remaining agent and even if the remaining agent did not self-protect at all, then he would not end up with a negative holding of bananas.⁷

An individual's consumption of bananas is the sum of his initial endowment and his production of picked bananas, plus his gains via transfer less his losses due to transfer. Since all individuals are identical, we will in what follows restrict ourselves to situations where each agent finds the same strategy optimal and let p , t , and x denote the common values of p^i , t^i , and x^i , respectively. In maximizing his consumption, an individual takes the behavior of all other agents as given. The gains to an individual via transfer from others are thus $(n-1)l(\bar{p}, t)$ and his losses are $(n-1)l(p, \bar{t})$, where bars indicate parameters taken as given by the individual. Each individual attempts to

$$\max_{p, t} V(p, t; \bar{p}, \bar{t}) = X + x + (n-1)l(\bar{p}, t) - (n-1)l(p, \bar{t}) \quad (M)$$

subject to the time constraint (T) and to non-negativity constraints on p , t , and x .⁸

It is not hard to show that if all individuals perform this maximization, a "law-of-the-jungle" equilibrium exists in which resources are devoted to attempted transfer and self-protection, as well as to picking bananas (see Appendix 1). The nature of the equilibrium is easily characterized. Since the first order conditions for any individual's maximization must hold in it, and since all agents find the same strategy optimal, we may remove the bars from these conditions:

$$-1 - (n-1)l_p(p, t) = 0 \quad (PP)$$

$$-1 + l_t(p, t) = 0 \quad (TT)$$

Total differentiation yields the slopes of the reaction curves PP and TT

$$\left. \frac{dp}{dt} \right|_{PP} = - \frac{l_{pt}}{l_{pp}} > 0$$

$$\left. \frac{dp}{dt} \right|_{TT} = - \frac{l_{tt}}{l_{pt}} < 0$$

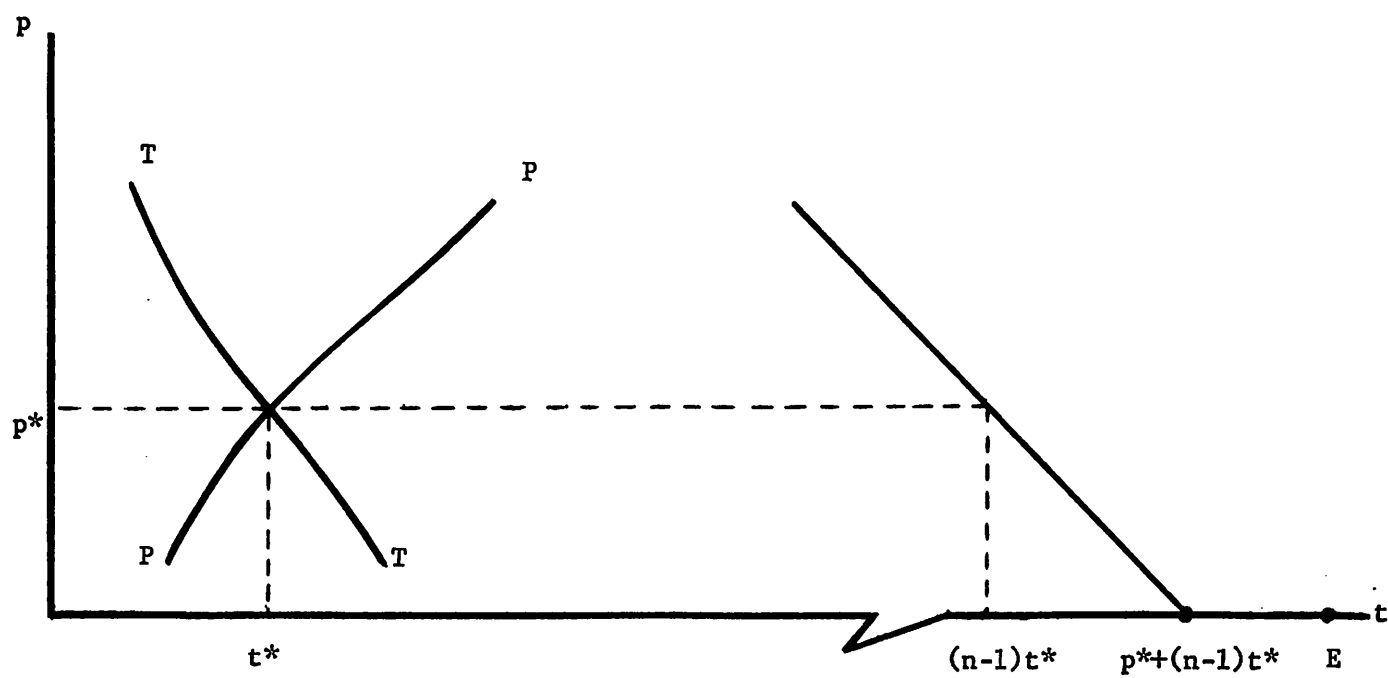
which are graphed in Figure 1. The equilibrium values of attempted transfer and self-protection are found to be t^* and p^* .⁹ By drawing a 135° line through the point $(n-1)t^*, p^*$, the total amount of resources devoted to transfer-related activities by an individual, $p^* + (n-1)t^*$, can be read off the abscissa. The difference between the endowed amount of time, E , and $p^* + (n-1)t^*$ is then the number of bananas picked by the individual. Final consumption is endowed bananas plus picked bananas, as net transfers must equal zero in a representative-individual equilibrium.

Three simple comparative static exercises can be performed on this equilibrium. Introducing a shift parameter in condition PP to represent the effects of a "pure" increase in the marginal productivity of resources devoted to self-protection (i.e., ℓ_p becomes greater in absolute value while all other partial derivatives remain constant) and differentiating, we see that the PP locus shifts out (to the left) and the equilibrium level of self-protection must rise while the amount of attempted transfer falls. (Formal proofs of this and other comparative static results for preconstitutional equilibria are provided in Appendix 2.) The outcome on final consumption is indeterminate; if the TT locus is sufficiently flat or the number of individuals sufficiently large, the decrease in time devoted to attempted transfer will dominate and more time will be left over for picking bananas so final consumption will increase. Otherwise, such "pure" improvements in the technology of self-protection will cause final consumption to fall.

On the other hand, "pure" increase in the marginal productivity of t causes TT to shift out and the equilibrium levels of both self-protection and attempted transfer must rise. This leads to an unambiguous fall in final consumption.

Note that such "pure" shifts in the marginal productivities of p and t will be rare. That is, it will often be the case that improving the technology of self-protection will simultaneously worsen the marginal productivity of resources devoted to

Figure 1



attempted transfer and vice versa. The outcome of these "impure" changes on final consumption must be indeterminate without further assumptions as they will induce shifts in both the PP and TT loci.

Finally, an increase in the number of individuals in the jungle causes PP to shift out but will have no effect on TT. This is because increases in the number of individuals wishing to transfer bananas to themselves raise the marginal productivity of self-protection. The equilibrium effects of such a change are thus similar to those deriving from a straight increase in the marginal productivity of p ; that is, final consumption can either increase or decrease depending on the slope of the TT locus and the number of individuals, as well as on the level of resources devoted to victimizing the new agent.

II. THE INTRODUCTION OF PROPERTY RIGHTS

The analysis above suggests that the individuals in our jungle would be better off if they could induce a fall in the marginal productivity of time devoted to attempted transfer since this would reduce the time spent on transfer-related activities and would allow more time to be spent producing bananas. This fact can be used to explain the emergence of property rights. In the simplest case, suppose it were possible to costlessly introduce and enforce property rights so that each individual had "the ownership of what belongs to him". Attempted transfer would be criminalized and termed attempted theft. Since enforcement of property rights was costless, no individual would ever be motivated to devote time to stealing bananas and no crime would occur. In terms of Figure 1, the TT curve would collapse to the origin.¹⁰ Self-protection would be pointless. Resources formerly expended on conflicts over control of bananas would instead be used to pick more bananas, and all would gain. In this way, the assumption of costlessly enforceable property rights leads to a world with no crime.

However, catching criminals, proving their guilt, and punishing them are generally costly. It is thus of interest to know how the private allocation of resources to theft, self-protection and picking bananas is influenced by the volume of resources devoted to maintaining property rights. To examine this, assume our n individuals collectively institute a criminal justice system which defines and enforces property rights. These activities are costly and are paid for via a tax of size z (assumed to be less than E) on each individual's endowment of time. The "size" of the criminal justice system, Z , is then measured as its total resource cost, nz times a "CJS-efficiency parameter", α ; i.e., $Z = \alpha nz$. Increases in α allow a given level of enforcement of property rights to be maintained with smaller per capita taxes.

Property rights are enforced only via the threat of punishment, which reduces the amount of time an individual has at his disposal.¹¹ Time lost to punishment is assumed to be non-socially-productive. This could be weakened either by letting time spent in punishment be used to pick more bananas which were then redistributed to the other members of society or by allowing punishment by direct retribution in bananas. Under either alternative specification, the social cost of time spent in punishment would be reduced or eliminated compared to the situation we consider and hence the case for a system of enforced property rights strengthened. Of course, it may then be asked why incarceration is oft-used as a form of punishment. Presumably, it is sometimes cost-efficient to achieve given levels of expected punishment with high punishment conditional on apprehension as this allows a lower probability of apprehension. This can be true even if one of the disadvantages of high conditional punishment is that criminals can't pay and hence must be punished in some other way (e.g., incarceration).¹²

The expected amount of punishment, S , to be served by individual i depends positively on the amount of self-protection by the other agents in society, the amount of time devoted by i to theft, and the size of the criminal justice

system; i.e., $S_p > 0$, $S_t > 0$, and $S_z > 0$. We assume that the marginal punishment for time devoted to theft increases with the level of private and collective protection ($S_{pt} > 0$ and $S_{tZ} > 0$) but is constant as a function of t ($S_{tt} = 0$). If no thefts are attempted, no punishment results, or $S(p, 0, Z) = 0$. Also, no punishment can result if the size of the criminal justice system is zero ($S(p, t, 0) = 0$).¹³

The purpose of the criminal justice system is to drive a wedge between the private costs and benefits from attempted transfer; the instrument of this purpose is punishment, which an individual regards as a tax in kind on t . The introduction of the enforcement mechanism thus enters the model by way of the time budget. Allowing for the per capita assessment of z and the expected amount of punishment, this becomes

$$E = p + (n-1)t + z + S(\bar{p}, t, \bar{Z}) + x \quad (T')$$

An equilibrium also exists for a jungle society where all individuals attempt the maximization (M) subject now to (T') and to non-negativity constraints on p , t , and x . As was the case in the preconstitutional world, conditions can be imposed which guarantee that theft and self-protection as well as picking of additional bananas all take place in this equilibrium (see Appendix 3).

The effects of enforced property rights on resource allocation in the model are two-fold (see Appendix 4 for formal proofs). First, benefits are conferred in the form of reduced expenditures on both attempted transfer and self-protection. This comes about as the presence of (or increases in the size of) the criminal justice system displaces the equilibrium in the model, causing the TT locus to shift in while the PP curve remains fixed. Second, the costs of enforcing property rights--in the form of the per capita tax z and the expected punishment S --impinge on each individual's budget. In terms of figure 1, the point $p^* + (n-1)t^*$ will fall but the change in final consumption of bananas will depend on whether or not this fall exceeds subtractions from the time endowment point, E , of $z + S$.

III. THE OPTIMAL ENFORCEMENT OF PROPERTY RIGHTS

Due to the generality of the model, we cannot show without further assumptions that the benefits from a system of enforced property rights exceed the costs. However, if the criminal justice system is sufficiently inexpensive to operate--that is, if a given level of Z can be obtained with a small enough per capita tax payment due to a high CJS-efficiency parameter --then reasonable assumptions permit the conclusion that all will be better off with some resources devoted to enforcement. One set of such assumptions is that as Z grows to some finite bound, the time devoted to theft by a representative individual falls off to zero, and that this causes the amount of punishment to also fall off to zero. Under these circumstances, it is possible to find large enough values of Z and α such that $Z/\alpha + S(p(Z), t(Z), Z)$ --the total cost to an individual of enforced property rights--is arbitrarily small, and thus smaller than the resource savings--in the form of decreased p and t --generated by the system of enforced property rights.

The decision to institute a system of enforced property rights--or more suggestively, to "erect a commonwealth"--is made jointly by the individuals in the original state. Since all are identical, unanimity about the "best" ex ante level of enforcement will prevail. This level is the Z which minimizes

$$\mathcal{L} = np(Z) + n(n-1)t(Z) + Z/\alpha + nS(p(Z), t(Z), Z)$$

which is the sum of the resources expended on theft, self-protection, running the criminal justice system, and losses due to punishment by all n individuals.

When the agents in our model pick Z to minimize \mathcal{L} , they are doing so to increase their own well-being. In this sense, the view of property rights presented here is positive: social order is not desired for its own sake but rather because it demonstrably increases the utilities of the individuals involved. However, the loss function \mathcal{L} (or rather its negative) can also be

interpreted as social welfare function. That is, since all individuals are identical, they will behave as if $-L$ is a welfare function, and will institute property rights and enforce them so as to maximize it. In this respect, our identical individual assumption fills the same purpose as the "veil of uncertainty" in Rawls' theory of justice--both make it possible to summarize the ex ante utility-maximizing behavior of individuals in social welfare functions.

This utilitarian basis for property rights and enforced prohibitions against property crimes allows us to examine the underpinnings of the normative, social-loss-due-to-crime function used in Becker's (1968) treatment of crime and punishment. Becker postulates that "net social damages" due to crime tend to increase with the number of offences; that is, that crime is a bad. The number of offenses can be reduced by stricter law enforcement, which involves both direct costs and losses due to punishment. With regard to transfer crimes--which is what our model focuses on (Becker's is more general)--he argues that "the value of resources used up in these crimes...are important components of...the net damages to society" (pp. 173-174).¹⁴ Our analysis sharpens this view. Not only are resources devoted to committing and protecting against crimes lost to more productive uses but the presence of these losses is central in explaining the decision to criminalize certain activities in the first place.

However, the central position occupied by these losses in a story of the criminal justice system--at least as regards transfer crimes--is obscured somewhat by Becker's formulation of net social damages depending solely on the amount of crime committed. The amount of crime need not be positively related to these losses. For instance, an increase in the size of the criminal justice system will reduce the level of resources devoted to committing crimes and to self-protection but may simultaneously increase the volume of transfers

(i.e., $\frac{d}{dz} (np(Z) + n(n-1)t(Z)) > 0$ does not imply $\frac{d}{dz} (n\ell(p(Z), t(Z))) < 0$,

even in equilibrium). This is so because (costly) private protection is undertaken precisely because of the transfers which it prevents, so the amount of transfer which actually does take place is not an unambiguous proxy for the resources expended on private protection.

Finally, it should be noted that the first-order condition for a minimization of \mathcal{L} is in effect the condition for the efficient allocation of a public good.¹⁵ Specifically, the marginal gains to all n individuals from increased enforcement of property rights--in the form of increased equilibrium resource savings on self-protection and attempted theft--are set equal to the marginal cost of running the enforcement mechanism plus the increase in aggregate punishment caused by increased enforcement. The fact that a mechanism of social order is essentially a public good suggests that the gains from instituting such a mechanism may be larger the greater the number of individuals involved. However, the law enforcement process is also likely to exhibit "crowding"; that is, the larger the number of individuals in society, the harder it will be to catch offenders and hence the greater the Z which would be required to achieve a given marginal punishment.

Appendix 1: Proof of existence of a non-cooperative equilibrium with $p > 0$, $t > 0$, and $x > 0$ for maximization (M) with constraint (T).

The set of feasible strategies is $F = \{(p, t) \mid E = p + (n-1)t + x, p \geq 0, t \geq 0, x \geq 0\}$ which is clearly a compact, convex, and non-empty subset of R^2 . Our earlier assumptions on $\ell(\cdot)$ assure that V is strictly concave in p and t so the maximization (M) has a unique optimal strategy pair.

Consider the mapping $\Delta: F \Rightarrow F$ defined by

$$\Delta(\bar{p}, \bar{t}) = \{(p, t) \in F \mid V(p, t; \bar{p}, \bar{t}) \text{ is maximized with } p, t \text{ satisfying the time budget (T)}\}.$$

By a widely used result (see e.g., Berge (1963, p 116)) Δ must be upper semi-continuous and, since it is single-valued, continuous. Brouwer's Theorem establishes that Δ has a fixed point. This fixed point is a non-cooperative equilibrium.

For equilibrium to have $p > 0$, $t > 0$, and $x > 0$, it is sufficient that the marginal productivities of p and t exceed their marginal costs (which always equal one by the way units are defined) for low, feasible p and t , and are less than marginal costs for high, feasible p and t . An example of such a preconstitutional equilibrium is the following. If the transfer function is $\ell = 100t^{1/2}p^{-1}$ (which clearly satisfies our assumptions about partial derivatives), and $n = 101$, $X = 150$, and $E = 200$, then $p^* = 79.37$, $t^* = 0.40$, $x^* = 80.94$ and $\ell = 1.26$.

APPENDIX 2

Comparative Statics of Preconstitutional Equilibria

A. Changes in the marginal productivity of time devoted to self-protection.

The equilibrium conditions can be written

$$-(n-1)\ell_p(p(\alpha), t(\alpha), \alpha) = 1 \quad (\text{PP})$$

$$\ell_t(p(\alpha), t(\alpha)) = 1 \quad (\text{TT})$$

where α is a shift parameter such that $\ell_{p\alpha} < 0$ (i.e., increases in α make p more productive). Differentiating with respect to α and solving for the equilibrium effects on p and t :

$$\frac{dp}{d\alpha} = - \frac{\ell_{tt} \ell_{p\alpha}}{D} > 0$$

$$\frac{dt}{d\alpha} = \frac{\ell_{pt} \ell_{p\alpha}}{D} < 0$$

where $D = \ell_{pp} \ell_{tt} - \ell_{pt}^2 < 0$. Total resources expended on transfer-related activities are $p + (n-1)t$ and

$$\frac{d}{d\alpha} [p + (n-1)t] = \frac{\ell_{p\alpha}}{D} [-\ell_{tt} + (n-1)\ell_{pt}] \quad (1)$$

This will be positive if $\frac{\ell_{tt}}{\ell_{pt}} > n-1$; i.e., if TT is steep enough or if n is small enough.

B. Changes in the marginal productivity of time devoted to attempted transfer.

Write the equilibrium conditions

$$-(n-1)\ell_p(p(\alpha), t(\alpha)) = 1 \quad (\text{PP})$$

$$\ell_t(p(\alpha), t(\alpha), \alpha) = 1 \quad (\text{TT})$$

where increases in α raise the marginal productivity of t ; i.e., $\ell_{t\alpha} > 0$.

Differentiation and solution gives

$$\frac{dp}{d\alpha} = \frac{\ell_{pt} \ell_{t\alpha}}{D} > 0$$

$$\frac{dt}{d\alpha} = - \frac{\ell_{pp} \ell_{t\alpha}}{D} > 0$$

where D is as above. Final consumption must fall with increases in α as $\frac{d}{d\alpha} [p+(n-1)t]$ is clearly positive.

C. Changes in the number of individuals. Write

$$-(n-1)\ell_p(p(n), t(n)) = 1 \quad (PP)$$

$$\ell_t(p(n), t(n)) = 1 \quad (TT)$$

to represent the dependencies of equilibrium values of p and t on n (note this formulation assumes that changes in n do not affect the technology of bilateral transfer conflicts). Differentiation and solution gives

$$\frac{dp}{dn} = - \frac{\ell_{tt} \ell_p}{(n-1)D} > 0$$

$$\frac{dt}{dn} = \frac{\ell_{pt} \ell_p}{(n-1)D} < 0$$

with D as above. Further

$$\frac{d}{dn} [p+(n-1)t] = \frac{\ell_p}{(n-1)D} [-\ell_{tt} + (n-1)\ell_{pt} + t]$$

This differs from (1)--which represented the effects of an increase in the marginal productivity of p on an individual's transfer-related time expenditures--in that the addition of new individual means 1) one is subject to more attempted transfer by others and this raises the marginal product of p (thus $\ell_{p\alpha}$ in (1) is replaced by $\ell_p/n-1$ here) and 2) there is an additional individual to attempt to victimize (hence the term t here).

Appendix 3: Proof of existence of a non-cooperative equilibrium with

$p > 0$, $t > 0$, and $x > 0$ for maximization (M) with constraint (T').

This proof involves the same mapping $\Delta: F \Rightarrow F$ as in Appendix 1 and is otherwise similar to the proof there. Note that the set of feasible strategies given (T'), $\{(p, t) \mid E - z - p - (n-1)t - S(\bar{p}, t, \bar{Z}) \geq 0, p \geq 0, t \geq 0\}$ is a non-empty, compact, and convex subset of G (for given \bar{p}, \bar{Z}). An example of an equilibrium with a criminal justice system is: let the transfer function be $l = 100t^{-1/2}p^{-1}$ and the punishment function be $S = 100tpZ^2$. If $n = 101$, $X = 150$, and $E = 200$, then in equilibrium we have $p^* = 26.34$, $t^* = 4.82 \times 10^{-3}$, $x^* = 160.47$, $S = 12.69$ and $l = 0.26$.

Appendix 4: Comparative Statics of the Criminal Justice System.

The conditions characterizing equilibrium behavior in the presence of a criminal justice system are derived from the first-order conditions for the maximization of an individual's consumption subject to (T'). In equilibrium, then

$$(n-1)l_p(p,t) = -1 \quad (PP)$$

$$l_t(p,t) - S_t(p,t,Z)/(n-1) = 1 \quad (TT)$$

The first of these is the same as in the preconstitutional state. The TT locus is modified, however. The direction of modification can be seen by holding p constant and calculating how the t satisfying (TT) varies with Z . Total differentiation of (TT) yields

$$\left. \frac{dt}{dZ} \right|_{p \text{ constant}} = \frac{S_{tz}}{(n-1)l_{tt}} < 0$$

Increases in Z thus shift the (TT) locus in, to the left.

The equilibrium effects of changes in Z on the optimal values of p and t follow from total differentiation of both (PP) and (TT).

These are

$$\frac{dp}{dZ} = \frac{-l_{pt} S_{tz}}{(n-1)D} < 0$$

$$\frac{dt}{dZ} = \frac{l_{pp} S_{tz}}{(n-1)D} < 0$$

where $D = l_{pp}l_{tt} - l_{pt}^2 + l_{pt}S_{pt}/(n-1)$.

FOOTNOTES

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¹ The starting point for Hobbes' and Rousseau's work is a world devoid of property rights; Locke, on the other hand, includes such rights in his original position. Note that the work of these early contractarians (especially of Hobbes) has formed the basis for the recent inquiries of Bush and Mayer (1973) into the distribution of wealth in a preconstitutional state and Buchanan (1975) on the emergence of a social constitution. Bush and Mayer's study is along lines similar to the present paper; it contains a formal model of distributional conflicts in a preconstitutional state but does not examine the emergence of property rights.

² Note that Becker considers crime generally; he does not restrict his attention to property (transfer) crime, as we do.

³ Endowing agents with positive units of bananas allows transfer to take place before production (of bananas) does. This assumption could be weakened at the expense of specifying how transfer is "produced" in more detail (see footnote 7). A simplifying assumption similar to ours has been used by Patinkin (1965) to eliminate production from his analysis of monetary exchange.

⁴This maximization simplifies matters by abstracting from the effects of uncertainty and behavior toward risk. A conjecture here is that risk-averse individuals would be more desirous than risk-neutral ones of a set of social-order-increasing, enforced property rights.

⁵cf Ozenne (1975) who postulates a similar transfer function.

⁶Activities such as physically harming intruders or threatening to take some of their endowments of bananas--i.e., protection via threat of economic sanction--are not permitted by this formulation.

⁷This embodies the notion that the marginal productivity of time devoted to attempted transfer decreases fairly rapidly. An alternative formulation of the transfer function would make the amount of bananas an individual could lose at any point of time depend on the number of bananas he held at that point of time. Such a formulation would result in a good deal of mathematical gymnastics and little gain in economic content.

⁸The stipulation that $x \geq 0$ amounts to an assumption of irreversibility in production.

⁹Equilibria will be stable if the ratio of the slopes of the reaction curves is less than one in absolute value; i.e., if $\ell_{pt}^2 / \ell_{pp} \ell_{tt} > -1$.

¹⁰The earlier assumption that $\ell_p(p, 0) = 0$ assures that the origin is on the PP locus.

¹¹Property rights could also be enforced directly; that is by impeding transfers. Formally, this would be represented by including Z as an argument in the transfer function. By including such direct enforcement, the case for collective enforcement would be strengthened.

¹²c.f. Becker (1968) for a discussion of the relative merits of fines versus incarceration.

¹³These assumptions follow from specifying $S = t \cdot \rho(p, Z) \cdot s(Z)$ where ρ is the probability (per unit t) of being punished and s is the magnitude of punishment. An increase in Z is assumed to lead to a greater probability of punishment as well as to greater punishment if caught (i.e., both catching thieves and punishing them are costly. An increase in private protection is assumed to increase the probability of apprehension (e.g., video cameras make it easier to catch thieves). The probability of apprehension should also be a (decreasing) function of n ; this dependency is suppressed notationally as n will be constant in what follows. Differentiation of S yields the partial derivatives given in the text. Note that this specification of S can be viewed as the reduced-form outcome of an optimization whereby the criminal justice system chooses the level of resources to be devoted to apprehension (ρ) and to punishment (s) separately in such a way as to maximize the expected punishment for any given level of total expenditures on apprehension and punishment. Explicit, separate consideration of the probability and severity of punishment would be important if the agents in the model were not risk-neutral.

¹⁴Our model permits an evaluation of Becker's conjecture that "If the theft or fraud industry is 'competitive', the sum of the value of the criminals' time input--including the time of 'fences' and prospective time in prison--...would approximately equal the market value of the loss to victims." In symbols, $(n-1)t(Z) + S(p(Z), t(Z), Z) = (n-1)l(p(Z), t(Z))$. This will not hold as the marginal gains from increased t (i.e., $(n-1)l_t$) are decreasing while the marginal costs $((n-1) + S_t)$ are increasing, so a net

surplus due to t is generated in equilibrium. In a representative-individual equilibrium this surplus just equals the net deficit due to victimization. An interpretation: the industry for transfer crimes is not competitive in the normal sense of the word, at least in a model where additional entry into the industry is impossible as all are already in it.

¹⁵ Tulkins and Jacquemin (1971) also view the criminal justice system as a public good. However, they neglect criminals in their formulation of the social loss function, writing it as (in our terms) $\mathcal{L} = np(Z) + Z$. Their approach is thus not contractarian; the purpose of their criminal justice system is to protect law-abiding members of society against outlaws.

References

- Becker, G., "Crime and Punishment: An Economic Approach," J.P.E., 76(169), 1968.
- Berge, C., Topological Spaces, Oliver and Boyd, London, 1963.
- Buchanan, J., The Limits of Liberty: Between Anarchy and Leviathan, University of Chicago Press, Chicago, 1975.
- Bush, W., and L. Mayer, "Some Implications of Anarchy for the Distribution of Property," J.E.T. (401), 1974.
- Coase, R., "The Problem of Social Cost," J. Law Econ., 3(1), 1960.
- Demsetz, H., "The Exchange and Enforcement of Property Rights," J. Law Econ., October 1964.
- Demsetz, H., "Toward a Theory of Property Rights," A.E.R., 57(347), proceedings, 1967.
- Hobbes, T., Leviathan, Penguin Books, 1976 (first published 1651).
- Locke, An Essay Concerning the True Original, Extent, and End of Civil Government, 1690, reprinted in E. Barker (ed.), Social Contract, Oxford University Press, 1970.
- Ozenne, T., "The Economics of Bank Robbery," J. Leg. Studies, 3(19), 1974.
- Patinkin, D., Money, Interest, and Prices, Harper and Row, 1965.
- Rawls, J., A Theory of Justice, Harvard University Press, Cambridge, Mass., 1971.
- Rousseau, J. J., Treatise du Contrat Social, 1762, translated in E. Barker (ed.) Social Contract, Oxford University Press, 1970.
- Skogh, G., "Straffrätt och Samhällsekonomi, dissertation, Lund, 1973.
- Tulkens, H., and A. Jacquemin, "The Cost of Delinquency: A Problem of Optimal Allocation of Private and Public Expenditures," discussion paper, Center of Operations Research and Econometrics, Haverlee, Belgium, 1971.